

Safety Data Sheet

Sodium azide

Division of Safety
National Institutes
of Health



WARNING!

THIS COMPOUND IS ACUTELY TOXIC AND MUTAGENIC. IT IS READILY ABSORBED THROUGH THE INTESTINAL TRACT. AVOID FORMATION AND BREATHING OF AEROSOLS.

LABORATORY OPERATIONS SHOULD BE CONDUCTED IN A FUME HOOD, GLOVE BOX, OR VENTILATED CABINET.

AVOID SKIN CONTACT: IF EXPOSED, WASH WITH SOAP AND COLD WATER. AVOID RUBBING OF SKIN OR INCREASING ITS TEMPERATURE.

SODIUM AZIDE IS FLAMMABLE AND EXPLOSIVE ON HEATING AND IN CONTACT WITH COPPER OR LEAD. KEEP AWAY FROM SPARKS AND OPEN FLAMES. IN CASE OF FIRE, USE WATER EXTINGUISHER.

FOR EYE EXPOSURE, IRRIGATE IMMEDIATELY WITH LARGE AMOUNTS OF WATER. FOR INGESTION, INDUCE VOMITING. DRINK MILK OR WATER. REFER FOR GASTRIC LAVAGE. FOR INHALATION, REMOVE VICTIM PROMPTLY TO CLEAN AIR. ADMINISTER RESCUE BREATHING IF NECESSARY. REFER TO PHYSICIAN.

IN CASE OF LABORATORY SPILL, WEAR PROTECTIVE CLOTHING DURING CLEANUP. AVOID SKIN CONTACT OR BREATHING OF AEROSOLS. USE WATER TO DISSOLVE COMPOUND. USE ABSORBENT PAPER TO MOP UP SPILL. WASH DOWN AREA WITH SOAP AND WATER. DISPOSE OF WASTE SOLUTIONS AND MATERIALS APPROPRIATELY.

A. Background

Sodium azide is a colorless and odorless white crystalline solid. It is highly toxic to man and animals and is mutagenic. Carcinogenicity has not been demonstrated. Accidental ingestion produces loss of consciousness, nausea, and headache. While sodium azide is not explosive, contact with copper or lead leads to formation of

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explosive heavy metal azides; also, on heating, the explosive hydrazoic acid is liberated. Sodium azide is used in chemical synthesis; as a herbicide, nematocide, and fungicide; as a vasodilator in treatment of hypertension; as a rocket fuel; and in the generation of nitrogen in safety air bags for automobiles and for airplane escape chutes. In the hematological and microbiological laboratory, sodium azide is a constituent of preservatives and of the diluting fluid for automatic blood cell counters.

A ceiling limit of 0.3 mg/m^3 of sodium azide has been recommended (ACGIH, 1987). It is classified as a Class B Poison.

Chemical and Physical Data

1. Chemical Abstract No.: 26628-22-8
2. Synonyms: Smite; NCI-CO6462; NSC 3072.
3. Chemical formula: NaN_3 . (The N_3^- anion is linear and consists of three resonance forms [Kleinhoffs et al., 1978].) Mol. wt. 65.02
4. Density: 1.846
5. Absorption spectroscopy: The ultraviolet spectrum (region 140-220 nm) and fluorescence spectrum (Deb, 1961), infrared (region 2-15 μm) (Lieber et al., 1951), and near infrared (1.2-2.8 μm) (Reid, 1966) spectra have been published.
6. Volatility: Sodium azide itself has low volatility. However, its solutions readily liberate hydrazoic acid (HN_3) which is volatile and toxic, even at room temperature, the rate of decomposition increasing with temperature. This decomposition takes place even in the presence of sodium hydroxide (Wear, 1975).
7. Solubility: 41.7% in water at 17°C , 0.314% in ethanol at 16°C . Soluble in liquid ammonia, insoluble in ether.
8. Description: White hexagonal crystals.
9. Melting point: 275°C with decomposition.
10. Stability: Solid sodium azide is relatively stable at room temperature in the dark. On irradiation with ultraviolet light it decomposes to sodium and nitrogen (Jacobs and Kureishy, 1966). On heating decomposition products include nitrogen, nitrogen oxides, hydrazine, and a metal residue. Aqueous solutions of sodium azide liberate hydrazoic acid.
11. Chemical reactivity: Hydrazoic acid is a weak acid, with a pK of 4.8, so that all solutions of sodium azide will contain unchanged HN_3 species. A 10% solution of sodium azide has a pH of 9.1. Sodium azide is highly reactive with both nucleophilic

and electrophilic agents. In addition to the previously mentioned potentially explosive reaction with copper and lead, it may also react violently with benzoyl chloride plus potassium hydroxide, bromine, carbon disulfide, chromium oxychloride, nitric acid, dimethylsulfate, and dibromomalononitrile. A useful synthetic application is its reaction with acyl chlorides to form acyl azides which on heating undergo the Curtius rearrangement to amines or isocyanates.

12. Flash point: No data.
13. Autoignition temperature: No data.
14. Explosion temperature: No data. Considered nonexplosive in pure form, except when heated near its decomposition temperature (275°C).
15. Flammable limits in air: No data.

Fire, Explosion, and Reactivity Hazard Data

1. Use water as fire extinguishant. Fire-fighting personnel should wear air-supplied respirators with full-face mask.
2. Sodium azide is incompatible with copper and lead (and possibly other heavy metals), carbon disulfide, and a variety of other compounds with which it reacts explosively particularly under conditions of fire.
3. Other incompatibilities include sudden heat (explodes around 300°C).
4. Hazardous decomposition products which may be evolved under conditions of fire include hydrazoic acid (toxic and explosive), nitrogen oxides, hydrazine, and nitrides.
5. Do not expose to sparks or open flames. Use non-spark tools and equipment.

Operational Procedures

The NIH Guidelines for the Laboratory Use of Chemical Carcinogens describe operational practices to be followed when potentially carcinogenic chemicals are used in NIH laboratories. The NIH Guidelines should be consulted to identify the proper use conditions required and specific controls to be implemented during normal and complex operations or manipulations involving sodium azide.

It should be emphasized that this data sheet and the NIH Guidelines are intended as starting points for the implementation of good laboratory practices when using this compound. The practices and procedures described in the following sections pertain to the National Institutes of Health and may not be universally applicable

to other institutions. Administrators and/or researchers at other institutions should modify the following items as needed to reflect their individual management system and current occupational and environmental regulations.

1. Chemical inactivation: Validated methods have been reported (NRC, 1983).
2. Decontamination: Turn off equipment that could be affected by sodium azide or the materials used for cleanup. If there is any uncertainty regarding the procedures to be followed for decontamination, call the NIH Fire Department (dial 116) for assistance. Use absorbent paper to mop up spill. Wipe off surfaces with water, then wash with copious quantities of water. Glassware should be rinsed in a hood with soap and water. Animal cages should be washed with water.
3. Disposal: It may be possible to decontaminate waste streams containing sodium azide before disposal. For details, see NRC, 1983. No waste streams containing sodium azide shall be disposed of in sinks or general refuse. Surplus sodium azide or chemical waste streams contaminated with sodium azide shall be handled as hazardous chemical waste and disposed of in accordance with the NIH chemical waste disposal system. No waste solutions should be allowed to enter the general drainage system (where it may come into contact with copper or lead drain pipes) until decontaminated. Where major quantities of azide are involved (such as the wastes from Coulter automatic blood cell counters), Wear (1975) recommends the installation of plastic or glass drainage systems; however, even under these circumstances azide solutions should first be decontaminated because of the high toxicity of sodium azide to bacteria in water-treatment plants. Solid wastes should be dissolved in water so as to ensure an azide concentration of less than 5% and the aqueous supernatant decontaminated as described above. Burnable waste (e.g., absorbent bench top liners) minimally contaminated with sodium azide shall be packaged for incineration in accordance with the NIH medical-pathological waste disposal system. Absorbent materials (e.g., associated with spill cleanup) grossly contaminated shall be handled in accordance with the chemical waste disposal system. Radioactive waste containing sodium azide shall be handled in accordance with the NIH radioactive waste disposal system.
4. Storage: Store solid sodium azide and its solutions in dark-colored, tightly closed containers, preferably under refrigeration. Avoid exposure to light, moisture, and heavy metals (copper, lead). Store working quantities of sodium azide and its solutions in an explosion-safe refrigerator in the work area. Do not store in ampoules since these could explode on heating.

Monitoring and Measurement Procedures Including Direct Field Measurements and Sampling for Subsequent Laboratory Analysis

1. Sampling: A method of air sampling of hydrazoic acid (released from sodium azide) has been described (Haas and Marsh, 1970). Monitoring of laboratory contamination by mutagens, using filter paper disks as surface wipes, solvent extraction, and testing in the Ames assay, is discussed by Peirce et al. (1979).
2. Analysis: Colorimetry of the red salt produced on addition of ferric ion to sodium azide solutions has been used in the past (e.g., Haas and Marsh, 1970). The method has the advantage of simplicity but suffers from instability of the red complex. More reliable is the reaction with pentacyanoamminoferrate which produces a stable violet color (read at 555 nm). Linear response is in the region 0.42-4.2 ppm (ca. 10^{-5} - 10^{-4} M) (Mehra and Garvie, 1980). All colorimetric procedures have the disadvantage of variable interference by a number of anions (particularly cyanide, thiocyanate, and thiosulfate). A microbiological assay, based on inhibition of RNA synthesis in E. coli, is described as not being influenced by these interferences. Useful range is 301,000 μ g sodium azide per ml (Walton and Elwell, 1980).

Biological Effects (Animal and Human)

Useful reviews of toxicological, including mutagenic, aspects of sodium azide have been published (Kleinhoffs et al., 1978; Frederick and Babish, 1982).

1. Absorption: Sodium azide is readily absorbed by ingestion and injection. Because of the ready liberation of hydrazoic acid, there is also a toxicological hazard through the skin, eyes, and inhalation.
2. Distribution: No data.
3. Metabolism and excretion: The only evidence concerning excretion of azide after administration by any route is negative--no unchanged azide (negative color reaction with ferric salts) is detected in urine. This is not surprising in view of the high reactivity of azides with nucleophiles and electrophiles including those in a biological environment. Evidence has been accumulating for the conversion of azide to a stable mutagenic metabolite, so far not identified, in barley seeds (Owais et al., 1978) and Salmonella (Owais et al., 1979, 1981).
4. Toxic effects: The acute LD50 in the mouse and rat by oral or parenteral administration is in the range of 15-45 mg/kg (for details see compilation by Frederick and Babish, 1982). The MLC50 (strength of solution which kills 50% of rats when

substituted for drinking water) is 0.05% (Williams, 1967). In man, the TDLo (lowest dose to produce any toxic effects) is estimated to be about 0.7 mg/kg (Richardson, 1975).

The most pronounced effect of azide administration is a dramatic and rapid lowering of the blood pressure due to vasodilation. This is particularly pronounced in hypertensive patients (Black et al., 1954), monkeys (Mettler and Sax, 1972), and rats (Kleinhoffs et al., 1978). There is little hypotensive effect in man and animals with normal blood pressure. Prolonged administration in animals produces histopathological changes in a variety of organs which are specifically pronounced in the cerebellum and cerebrum (substantia nigra) (Mettler, 1972; Mettler and Sax, 1972). Sublethal doses in animals by all routes of administration result in increases in respiration, urination, and defecation leading to collapse. Effects of topical application of sodium azide to the rabbit eye include marked increases in intraocular pressure, probably due to stimulation of aqueous humor flow (Krupin et al., 1977). Several cases of accidental poisonings in man have been described (Burger and Bauer, 1965; Roberts et al., 1974; Richardson et al., 1975). Ingestion resulted in hyperventilation and hypotension, increased pulse rate, nausea, and headache. With higher doses there was vomiting of yellowish material, diarrhea, and polydipsia. Symptoms disappeared overnight in mild cases, and after several weeks in more severe ones.

The biochemical effects of sodium azide appear to be several. The azide ion is an inhibitor of cellular oxidation similar to cyanide, with inhibition of cytochrome oxidase and other oxidative enzymes; however, the affinity of azide to metalloproteins is much lower than is that of cyanide. A specific effect, demonstrated in vitro (Kimura et al., 1975) and on topical eye application (Krupin et al., 1977) is an increase in cyclic GMP and in guanylate cyclase activity (an effect not found with cyanide), with no effect on cyclic AMP.

Carcinogenic effects: Several studies have failed to demonstrate any carcinogenic action of sodium azide. This is surprising in view of its strong mutagenic activity (for discussion see below).

Mutagenic and teratogenic effects: Sodium azide is an effective mutagen in plants (Owais et al., 1978) and bacteria (Arenaz et al., 1983) and is in fact used as a positive mutagen control in the Ames test (Dunkel, 1979). The effect in mammalian cells is conflicting. It is a weak mutagen for Chinese hamster cells and does not induce dominant lethals in rats. It is believed that it does not interact directly with DNA and may be an indirect-acting mutagen. This conclusion, if correct, may explain the lack of carcinogenicity of sodium azide. For a more complete discussion see Frederick and Babish, 1982.

Emergency Treatment

1. Skin and eye exposure: For skin exposure, remove contaminated clothing and wash skin with soap and water. Avoid rubbing of skin or increasing its temperature. For eye exposure, irrigate immediately with copious quantities of running water for at least 15 minutes. Obtain ophthalmological evaluation.
2. Ingestion: Drink plenty of water or milk. Induce vomiting. Refer for gastric lavage.
3. Inhalation: Remove victim promptly to clean air. Administer rescue breathing if necessary.
4. Refer to physician at once.

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